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THEMATIC INSIGHTS

Green machines: the future of transport

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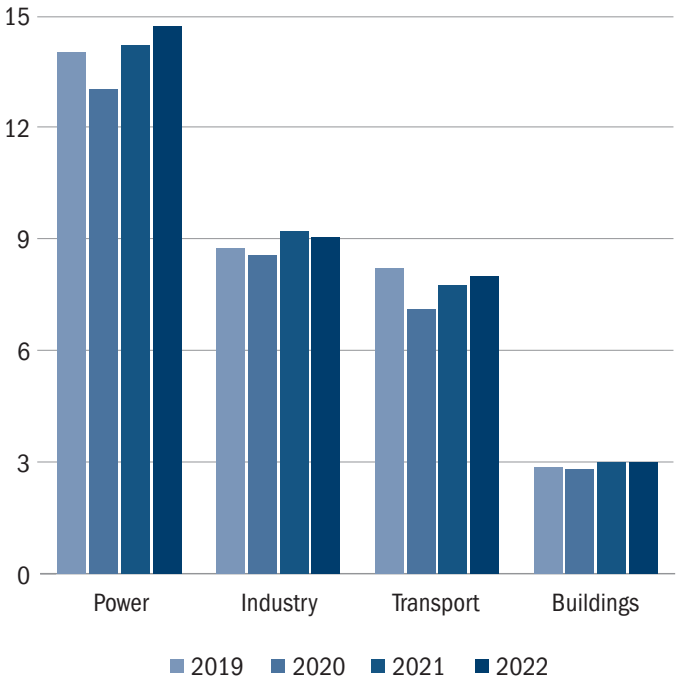
At a glance

- The transportation sector has a significant impact on global emissions, but technology innovations, policy changes and shifting behaviours can reduce this
- Government regulatory timelines and international treaties are adding some urgency to the process, with many firms committing to net zero emissions by 2050
- As part of this energy transition, it is essential that companies in this sector adapt their products to serve clients effectively while remaining commercially viable

Issued March 2024

The transportation sector is largely powered by petroleum-based fuels, and contributes about 25% of global greenhouse gas (GHG) emissions (Figure 1). Clearly, there is a need to move people and freight, but leading global economies are working to decarbonise the sector through technological innovation, policy change and greater efficiency.

Figure 1: Global CO2 emissions by sector, 2019-2022



Source: IEA, CO2 Emissions in 2022, March 2023. Note: transport includes international bunkers

Regional regulatory approaches

Many governments are taking action to accelerate the net zero transition for the transport sector, either by disincentivising the production and use of vehicles that emit GHGs, or incentivising that of low-emission vehicles and fuels. Policy approaches for transport can be divided into four main categories: emission trading schemes (ETSs), emission standards for vehicles, fuel standards, and low carbon technology incentives (Figure 2).

Some jurisdictions, including the EU and UK, are set to phase out internal combustion engine vehicles

Figure 2: Approaches to decarbonisation

Emission trading schemes	Emissions standards for vehicles	Fuel standards	Low carbon technology incentives
Operate on a "cap and trade" principle, whereby a cap is set on the total amount of GHGs that can be emitted by sectors covered. The cap reduces over time. Many such schemes cover transport including in the EU, the UK and the US. Aviation emissions will be covered by the UN's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). ETS success depends on the applied carbon price. Those in the UK and EU are far higher than comparable schemes and act as a stronger incentive to reduce emissions. Schemes are most relevant for transport companies with high Scope 1 emissions: shipping, airlines and logistics companies.	Limit the amount of air pollutants cars can release. Examples include the forthcoming EU Euro 7 and US CAFE standards, and for heavy duty vehicles the EPA's Phase 3 standards in the US, the ICAO's CO2 standard for new aircraft, and the International Maritime Organisation's (IMO) Carbon Intensity Indicator for ships. Some jurisdictions, including the EU and UK, are set to phase out internal combustion engine vehicles or embed zero-emission vehicle requirements in public procurement policies – for example the EU Clean Vehicles Directive. Low- or zero-emission zones have also become popular, especially in Europe.	Deployed by policymakers to reduce air pollution and the carbon intensity of fuels. The California and EU low-carbon fuel standards are examples that have seen ethanol blended into vehicle fuels to reduce emissions. Fuel standards are increasingly being used for other transportation sectors, for example, sustainable aviation fuel (SAF) mandates being deployed in the EU and UK.	Most developed countries have purchase rebates, tax exemptions or tax credits to encourage the adoption of zero emission vehicles. The US IRA is most comprehensive, offering tax credits for light-, medium- and heavy-duty vehicles, as well as for SAF, hydrogen and ammonia production, which will help these fuels approach price parity with fossil fuels and help decarbonise aviation, railroads and shipping.

Innovation across air, land and sea

> Aviation

Airlines are willing to pay for better quality and more fuel-efficient planes, with each generation of aircraft up to 25% more efficient than the previous[1]. For example, widebody airlines that once needed four engines for transatlantic flights now only need two due to improvements in power and efficiency. This reduces fuel costs and maintenance spends, the latter making up a large proportion of airlines' costs. SAF will be a major part of decarbonisation pathways in the future, but significant barriers exist to reducing current high costs and scaling production[2].

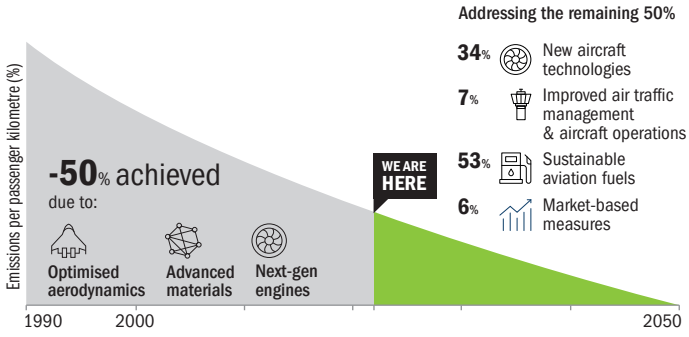
Additional aircraft technologies are also being tested. Airbus aims to bring the first hydrogen-powered commercial aircraft to market by 2035. This would produce only water as a by-product, and if the hydrogen is sustainably sourced could be a key solution. However, additional work is required in terms of technology and infrastructure.

[1] International Air Transport Association, Net zero 2050: new aircraft, December 2023
[2] Columbia Threadneedle Investments, Jet zero – how investors can get on board for the long haul of aviation decarbonisation, Joe Horrocks-Taylor, 18 August 2022

Electric planes are perhaps not feasible for commercial aviation due to the sheer weight of the battery that would be required for effective propulsion, but could be utilised for smaller aircraft.

There are also operational efficiencies that can be exploited, including identifying more straightforward flight paths, utilising artificial intelligence to reduce airport congestion, and ensuring pilots fly at optimal altitudes and speeds for efficient fuel consumption (Figure 3).

Figure 3: Aviation's decarbonisation pathway



Source: Airbus, Decarbonisation, Towards low-carbon air travel for future generations, 2023

> Rail

Rail produces 14g of carbon dioxide equivalent per passenger kilometre compared with 166g for cars and 261g for air travel[3]. The EU has set a target to increase rail freight's modal share from 18% to 30% by 2030[4].A key part of this is ensuring adequate investment in rail infrastructure, as well as continued taxation on road vehicles.

Fleets will need to be more efficient with bigger train sizes for additional loading and optimised energy consumption. The electrification of lines will be key, but the pace of adoption varies. Regions with very long distances and poor infrastructure are lagging (only 1% of the North American rail network is electrified). Alternative energy sources such as battery power, biofuels and hydrogen could also be explored. Alstom, a European train manufacturer, has been trialling fuel cell and hydrogen trains in different regions. Its first test demonstration of a hydrogen-powered train in North America in 2023 averted 22 tons of CO2 emissions over 2.5 months compared to the diesel trains that normally serve the route's non-electrified lines[5]. Improvements in the infrastructure around hydrogen fuel production and distribution will further aid adoption. US manufacturer Wabtec is pioneering hybrid and battery-powered locomotives, mostly for yard operations and shorter routes.

> Buses, cars and trucks

The focus for vehicle manufacturers is on the shift from traditional internal combustion engines (ICE) to battery electric vehicles (BEVs) and hydrogen fuel cell electric vehicles (FCEV). Different use cases require different approaches. For example, buses are used in inner cities with easy access to charging stations. Alongside the regularity of routes and the need for improved air quality in these areas, there has been a relatively quick transition to BEVs. Electric city bus sales recently overtook diesel in Europe due to stringent regulation.

BEVs are expected to be the dominant type of passenger car, and accounted for 29% of new car registrations in China[6] and 22% across Europe in 2022[7]. A key barrier has been building adequate infrastructure to combat "range anxiety". Pricing has also been a focus point, with US car manufacturer Tesla slashing prices to encourage take up. As the production of these cars scales up, firms should see better efficiencies in production and input costs. Chinese players have been able to carry this out effectively, and in a market where customers' purchasing decisions are easily swayed this remains a threat to big incumbents. FCEVs will also be part of the mix in car transport, but currently have high upfront/running costs as well as a lack of refuelling infrastructure, which makes them a hard sell for consumers.

In truck markets the most important factor is the total cost of ownership (TCO). This generally works out to be roughly a third for the initial cost, a third for fuel and a third for road and maintenance. While the TCOs for ICE versus BEVs/FCEVs has not reached parity, firms are purchasing zero-emission vehicles (ZEVs) to meet their climate goals, and TCO parity is projected to be reached in most jurisdictions for daily mileages of less than 750 by 2030[8].

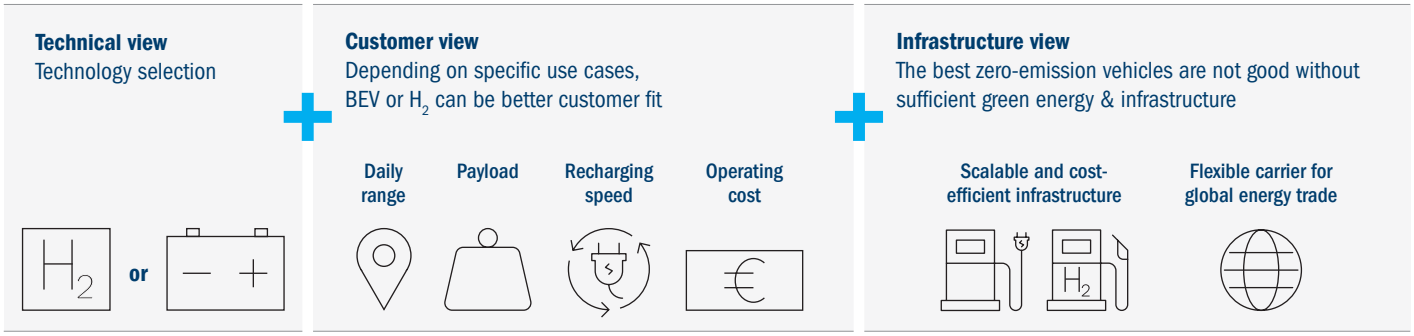
ZEV truck sales are approximately 3% of sales[9], but the big players have set ambitious targets. Volvo Trucks is aiming for approximately 50% ZEV production by 2030. In Europe, BEVs are suitable for most use cases, with their standard range of around 300 kilometres covering most journeys.

The shift to electric vehicles also allows for a move to autonomous vehicles (AVs), which could potentially reduce truck TCOs further by reducing the costs associated with hiring drivers.

Longer journeys of 1,000 kilometres-plus could be suitable for hydrogen-fuelled trucks, with battery size requirements ruling out BEVs (Figure 4). Hydrogen combustion engines allow for the use of an ICE drivetrain, while FCEVs rely on battery drivetrains. FCEVs will be commercially available in the second half of this decade. The US market will likely see a larger uptake of hydrogen trucks due to the longer nature of journeys and a lack of infrastructure in remote or rural areas. However, TCOs are not expected to reach parity with BEV/ICE until the mid-2030s at the earliest[10].

[3] IEA, CO2 Emissions Statistics "Special Report: Global Warming of 1.5C", IPCC 2018
[4] European Union Agency for Railways, Getting Rail Freight on the Right Track, 29 March 2023
[5] Alstom, Alstom concludes the successful demonstration of the first commercial service hydrogen-powered train in North America, 10 October 2023
[6] Canalys, Global EV market grew 55% in 2022 with 59% of EVs sold in Mainland China, 15 March 2023
[7] European Environment Agency, New registrations of electric vehicles in Europe, 24 October 2023
[8] ICCT, Total Cost Of Ownership Of Alternative Powertrain Technologies For Class 8 Long-Haul Trucks In The United StateS, April 2023
[9] Zev Transition Council, ROADMAP TO 2030: Enabling a Global Transition to Zero Emission Vehicles, July 2023
[10] ICCT, Total Cost Of Ownership Of Alternative Powertrain Technologies For Class 8 Long-Haul Trucks In The United States, April 2023

Figure 4: Volvo Trucks' view on battery versus hydrogen ZEVs



Source: Volvo Trucks, 2023

> Marine

Three ship types dominate international shipping's GHG emissions: container shipping, bulk carriers and oil tankers. These have long lifespans of 25-30 years, so modernisation and better management of the existing fleet have been key considerations for emissions reduction. Large shipping firms have made progress by retrofitting exhaust gas cleaning systems, cold ironing (plugging into onshore power sources while berthed) and improving the shapes of bows and propellers.

Speed reduction, proper hull maintenance and efficient planning of voyages also reduce overall emissions. Implementing these measures across the global fleet could deliver 25%-30% carbon savings[11], and is the primary route for the sector achieving the International Maritime Organisation's 2030 decarbonisation targets[12]. However, the technological developments in alternative fuels and engines will be most impactful in the medium term, with the main focus being on ammonia, hydrogen and methanol.

Methanol and ammonia are anticipated to be particularly cost competitive as well as easy to store and transport. Last year, Maersk, a European shipping/logistics company, launched the first green methanol-powered ship on a journey from South Korea to Denmark. To meet the 2040 target of net zero emissions, the firm aims to transport a minimum of 25% of ocean cargo using green fuels by 2030. New ships will need to have dual fuel engine technology in readiness for when green fuel production reaches the appropriate scale. The adoption of zero emission fuels for ships will also require infrastructure development which is being achieved through industry collaboration.

Conclusion

Society will experience a big shift in both technology and behaviour in the transportation sector to address the energy transition and associated carbon emissions goals. Products offered by firms will continue to see innovation aided by changes in regulation and the provision of appropriate infrastructure.

[11] Global Maritime Forum, Getting to Zero Coalition
[12] Columbia Threadneedle Investments, Smooth sailing or all at sea: what does the new shipping net zero target mean for investors? Joe Horrocks-Taylor, 4 August 2023

Get to know the authors

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Ebele joined Columbia Threadneedle Investments in 2017 and covers European and UK industrial companies with a focus on transportation. Ebele has seven years of investment experience, starting her career as a Junior Financial Adviser at a wealth management firm in Abu Dhabi. She holds a BSc (Hons) in Economics and an MSc in Data Science & Artificial Intelligence. She also holds the Investment Management Certificate, CISI International Certificate in Wealth & Investment Management and CFA Certificate in ESG Investing.

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Joe joined Columbia Threadneedle's Responsible Investment team in 2021 as a climate and biodiversity specialist. His role involves supporting the firm's net zero strategy, as well as engaging with holding companies on climate and biodiversity, especially within the transport sector. Prior to joining Columbia Threadneedle, Joe worked as a sustainability consultant with a range of private and public sectors. Outside work he enjoys playing sport, hiking and birdwatching.

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